

Tank AY-102 Leak Assessment

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November 7, 2012



Leak Assessment Conclusion

- *Leak Conclusion*

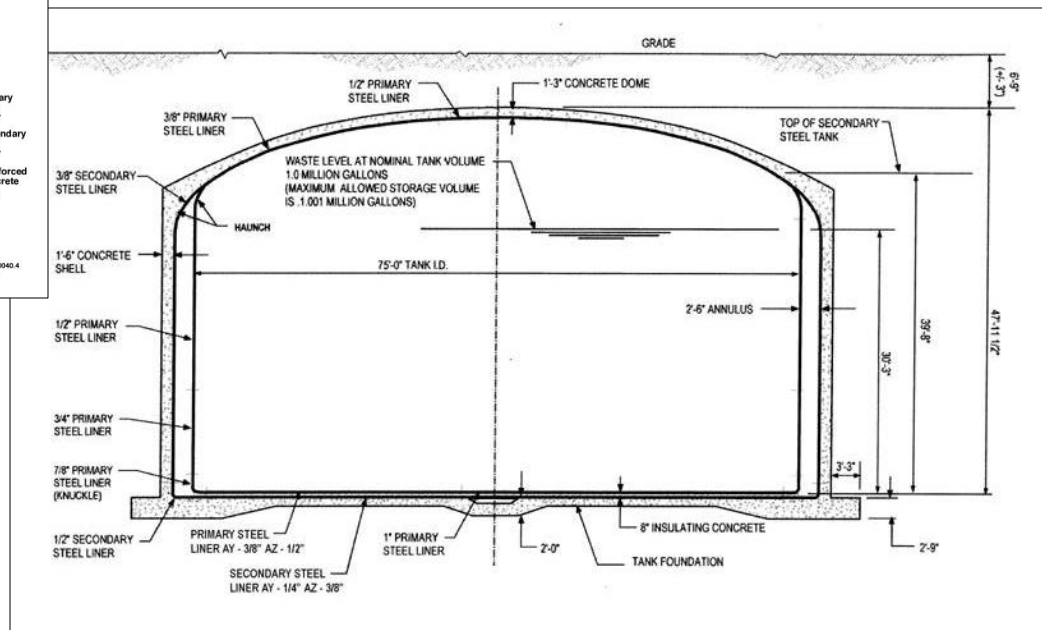
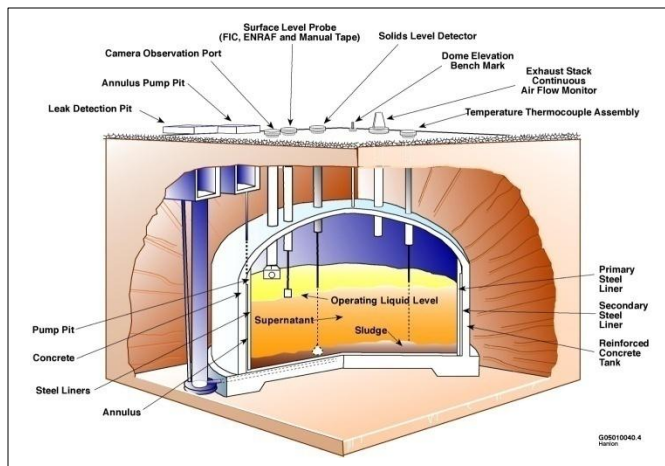
The source of radioactive material discovered in the tank AY-102 annulus near Risers 83 and 90 is a leak from the primary tank.

- *Probable Cause*

Possible corrosion at high waste temperatures compounded by mechanical impacts to a tank whose waste containment margins had been reduced by construction difficulties.

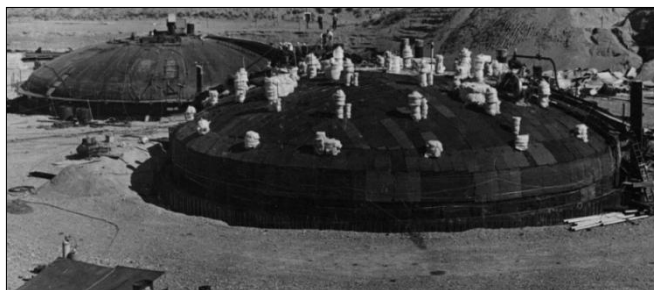
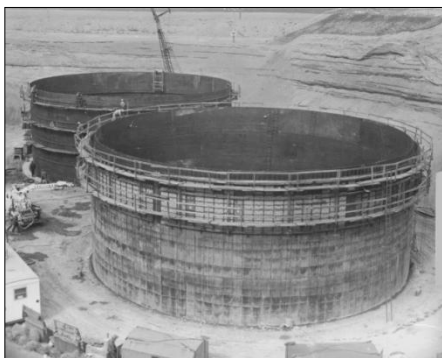
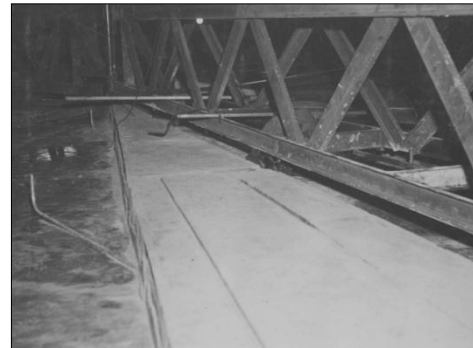
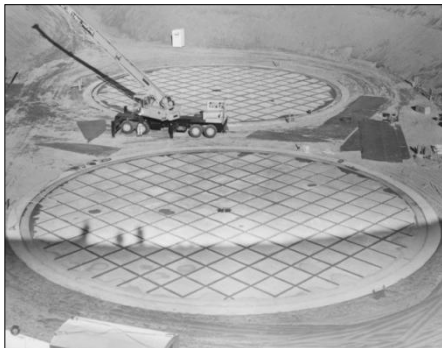
241-AY Double-Shell Tank Cross Section

- **Tank AY-102 was the first double-shell tank constructed at Hanford**





Construction Sequence



Annulus Inspections: Sites with Found Material



8/10/2012 Riser 90



8/10/2012 Riser 90

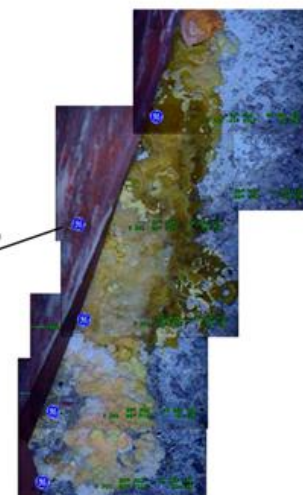
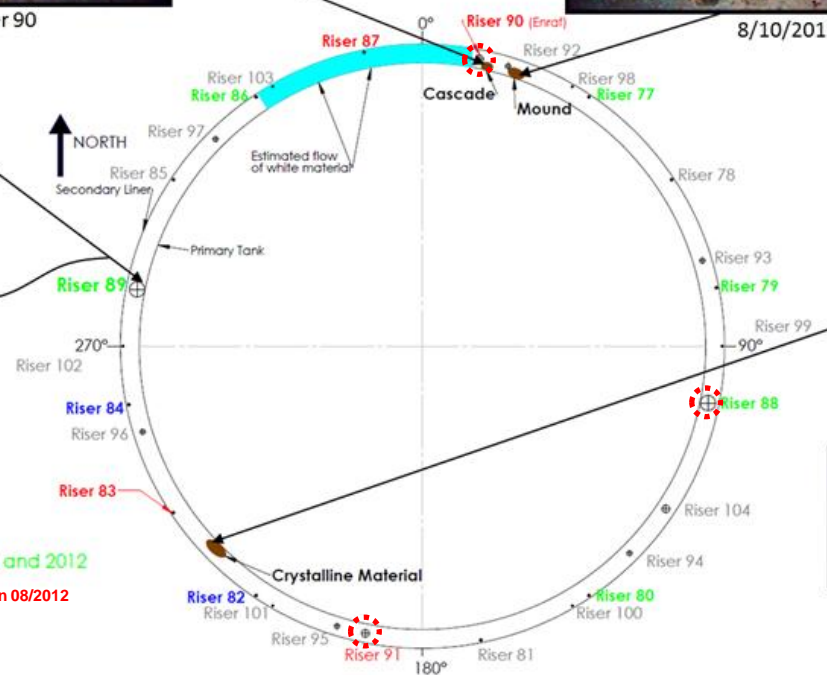
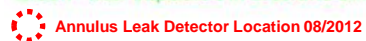


8/1/2012 Riser 89

Blue - Riser inspected in 2006

Red - Riser inspected in 2012

Green - Riser inspected in 2006 and 2012



9/10/12 Riser 83

T.J. Barnes
10/22/2012

Annulus Sample Results

- Annulus Floor Material near Riser 83, September 26, 2012:
 - 45 mR/hr “Window Open”
 - Principal Chemical Constituents: NaNO_3 , Na_2CO_3 , NaNO_2 , KNO_3 ¹
 - Principal Radionuclide Constituents: Sr-90, 0.120 $\mu\text{Ci/gm}$; Cs-137, 90.9 $\mu\text{Ci/gm}$ (202 million disintegrations per minute per gram)
- Annulus Floor Material near Riser 90, August 10, 2012:
 - 800,000 dpm reading reported with detector near sample²

¹ In 1994, 4,000 gallons of KOH containing about 2,600 pounds of potassium were added to tank AY-102 to increase the pH. The tank AP-101 supernatant transferred into tank AY-102 in contained a significant potassium inventory. Tank AY-102 has second highest potassium inventory of any Hanford waste tank.

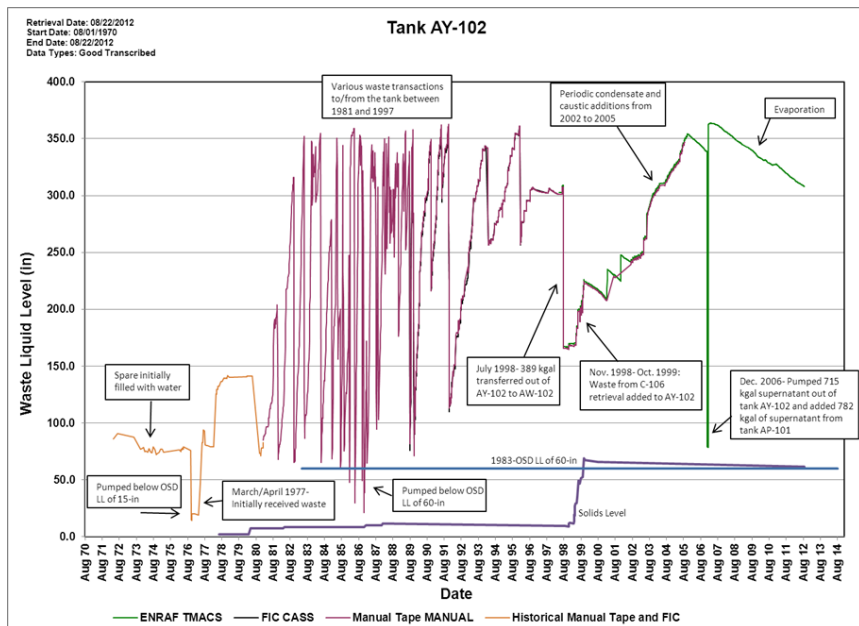
² Laboratory results from material collected near Riser 90 on October 15, 2012 are consistent with the results from the Riser 83 sample.

Corroborating Evidence of Leakage

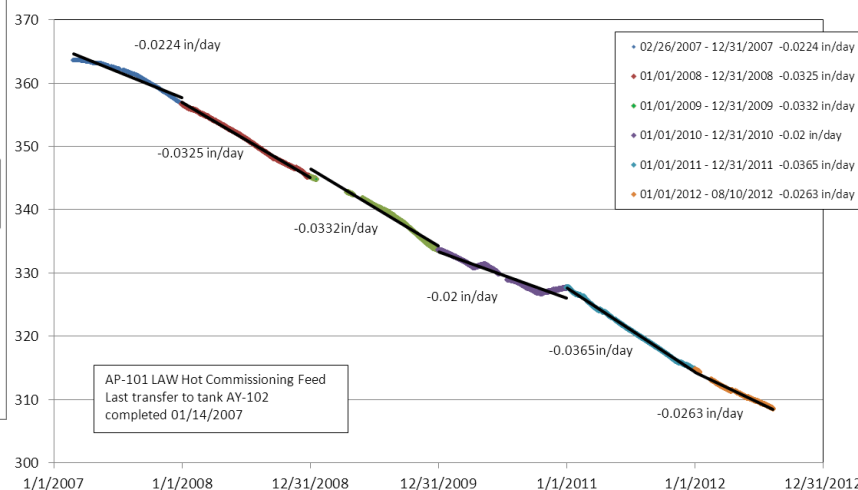
Corroborating Evidence of Leakage	Yes	No
Liquid Level Changes		X
Chemistry	X	
In-Tank Corrosion Probe		X
Primary Tank Ultrasonic Wall Inspections		X
Waste Temperature		X
Tank Dome Deflection and Tank Settlement		X
Fill Cycle Fatigue		X
Tank Construction	X	



Liquid Level Changes



Tank AY-102 Liquid Level Decrease 2007-2012

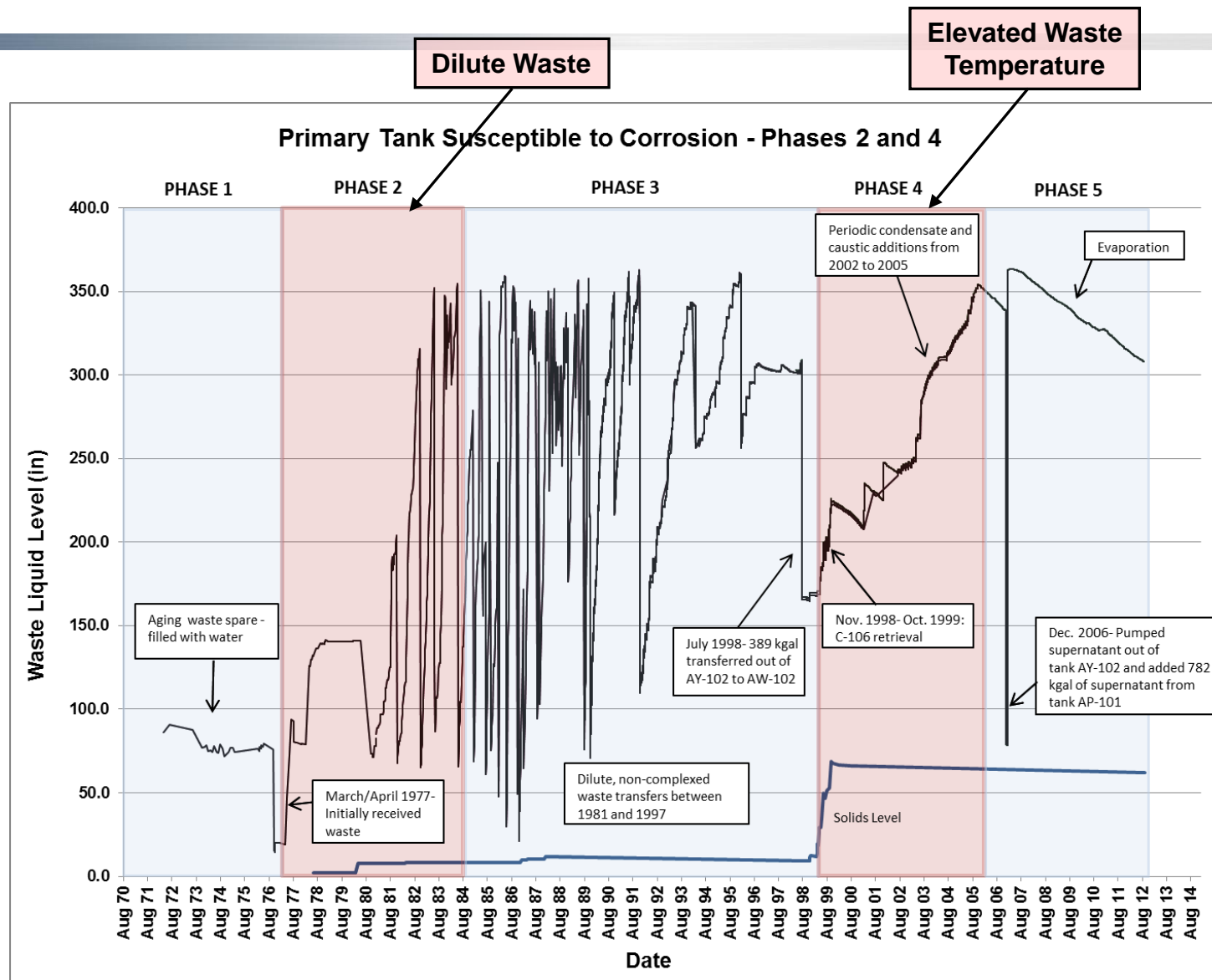


- Tank C-106 sludge retrieval during 1998 – 1999 increased the tank heat load by ~ 94,000 BTU/hr
- Since AP-101 transfer in 2007, evaporation rate has averaged ~ 77 gal/day, or ~ 28,000 gal/year
- **A small, episodic leak could occur undetected inside the evaporation rate**

- Parameters influencing corrosion of carbon steel liner:
 - Aggressive ions (Nitrate, Carbonate, Chloride)
 - Inhibitory ions (Hydroxide, Nitrite)
 - Temperature
- Two main corrosion concerns for Hanford waste types:
 - Stress Corrosion Cracking in presence of high nitrate ion or carbonate ion concentrations
 - Pitting Corrosion in presence of nitrate or chloride ion concentrations
- Five chronological chemistry phases based on susceptibility to corrosion
 - The first solids layer deposited in tank AY-102 in 1979 – 1984 (“Phase 2”) may have the characteristics which cause corrosion when subjected to higher temperatures experienced after 1999 (“Phase 4”).

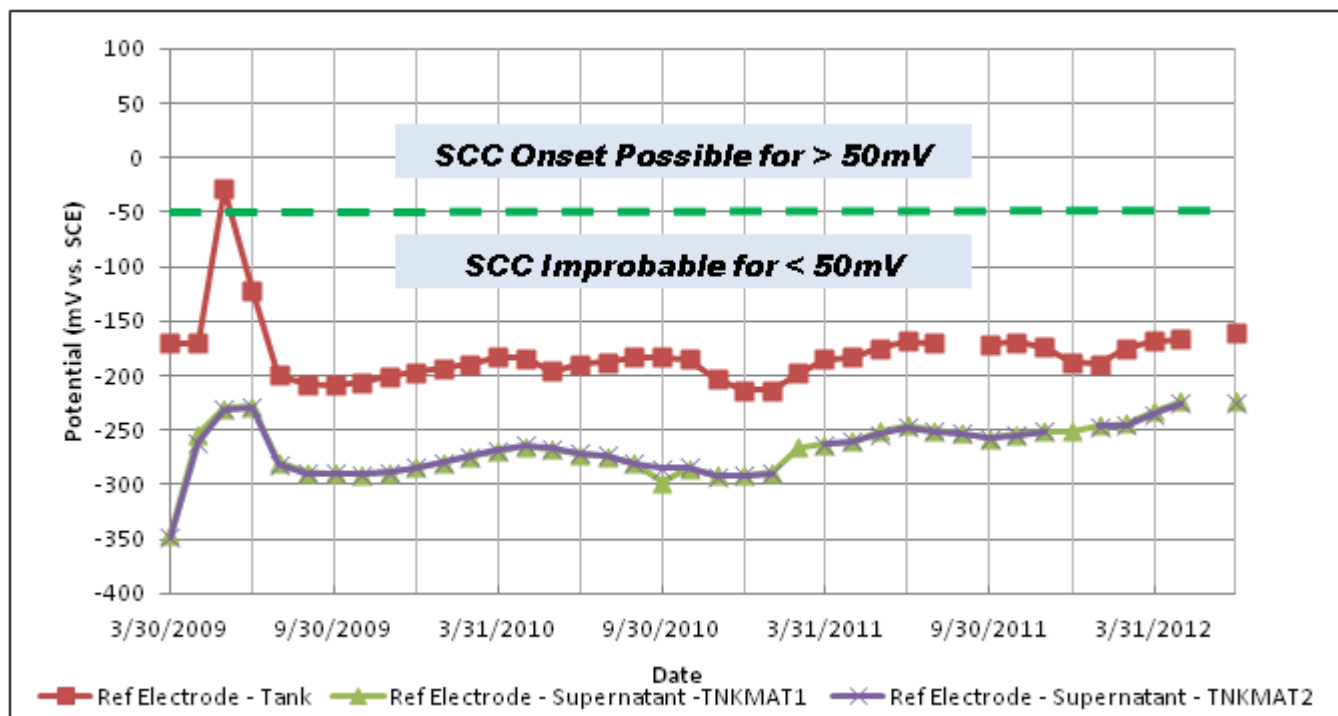


Chemistry (cont.)





In-Tank Corrosion Probe

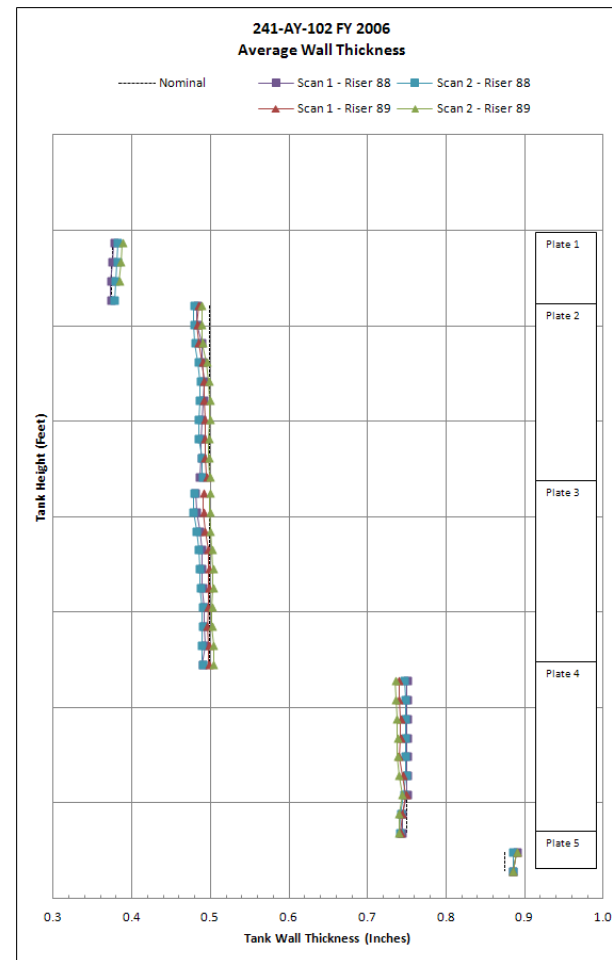


- Installed in March, 2009
- Electrodes located in supernatant and sludge layers and vapor space
- Sludge electrodes failed during corrosion probe installation. No readings are available.



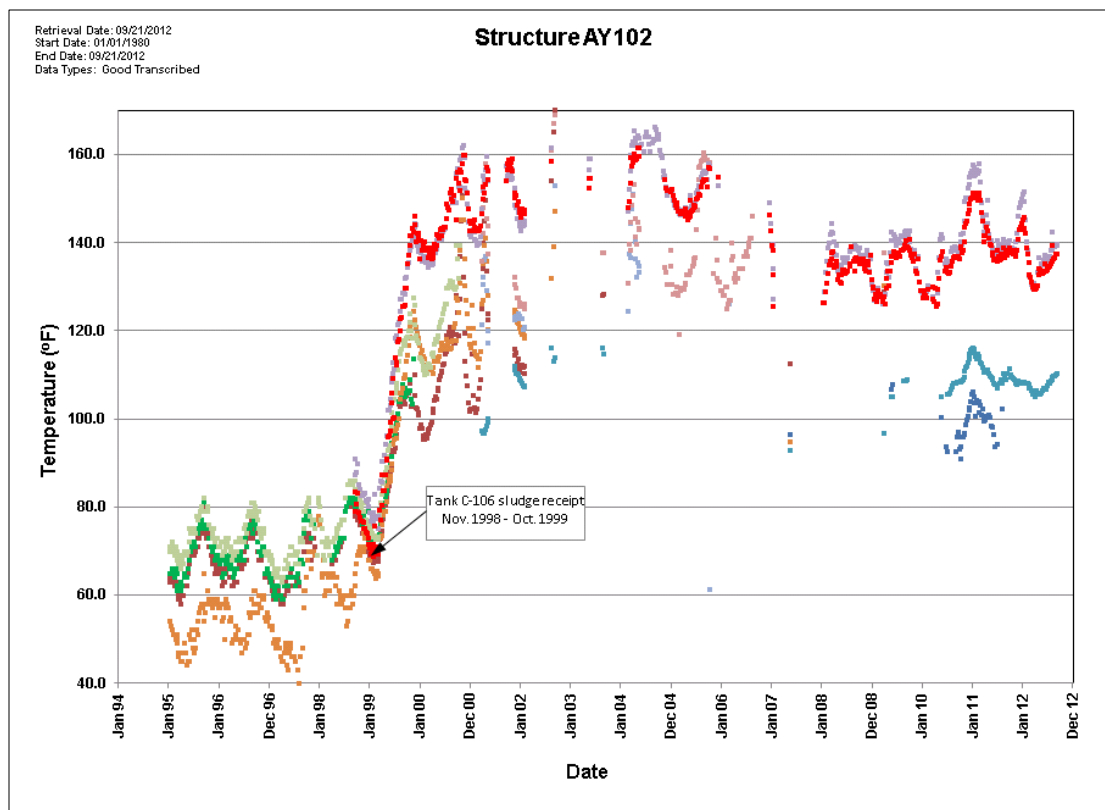
Primary Tank Ultrasonic Wall Inspections

- In 2006 vertical scan pairs were completed in Risers 88 and 89 on surfaces
- **No significant primary tank wall loss has been detected by ultrasonic wall thickness scans**





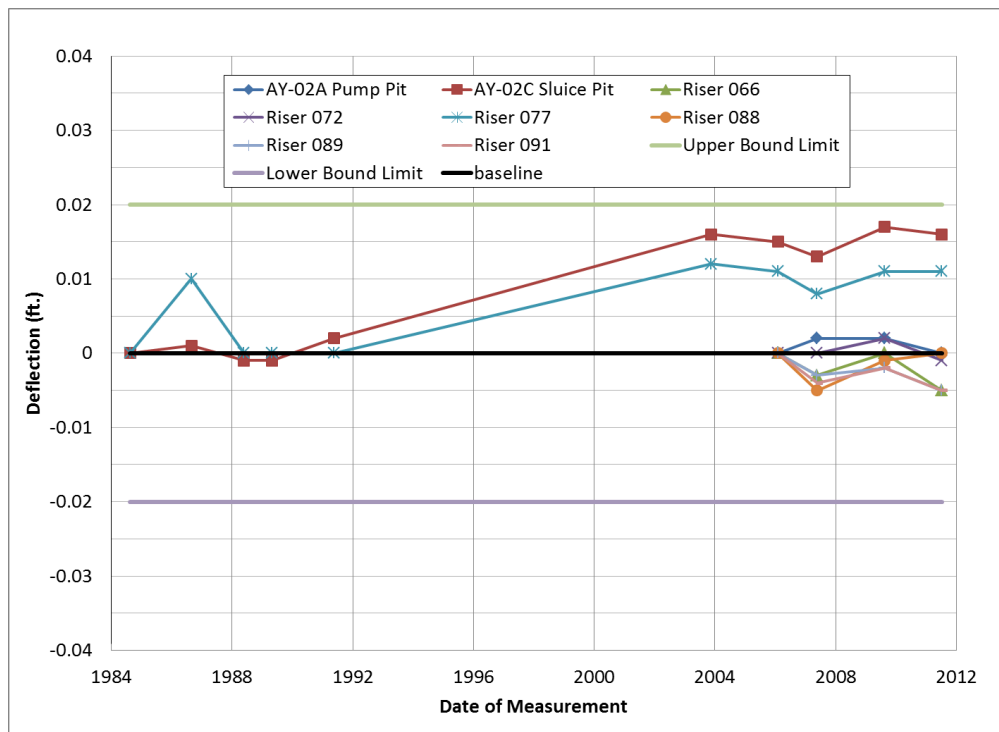
Waste Temperature



- Tank design and structural modeling temperature was 350°F; operating limit is 260°F
- From available records, highest waste temperature recorded is ~189°F in the sludge
- **Waste temperatures have been well within analyzed and allowable limits.**



Tank Dome Deflection and Tank Settlement



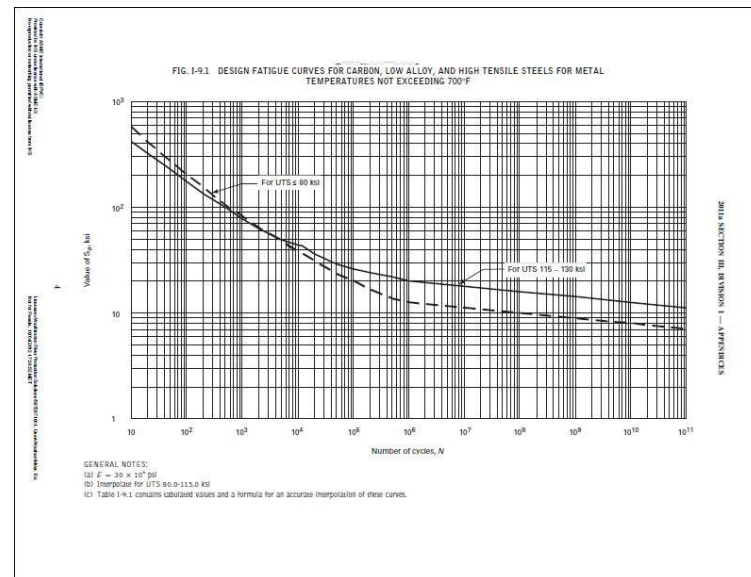
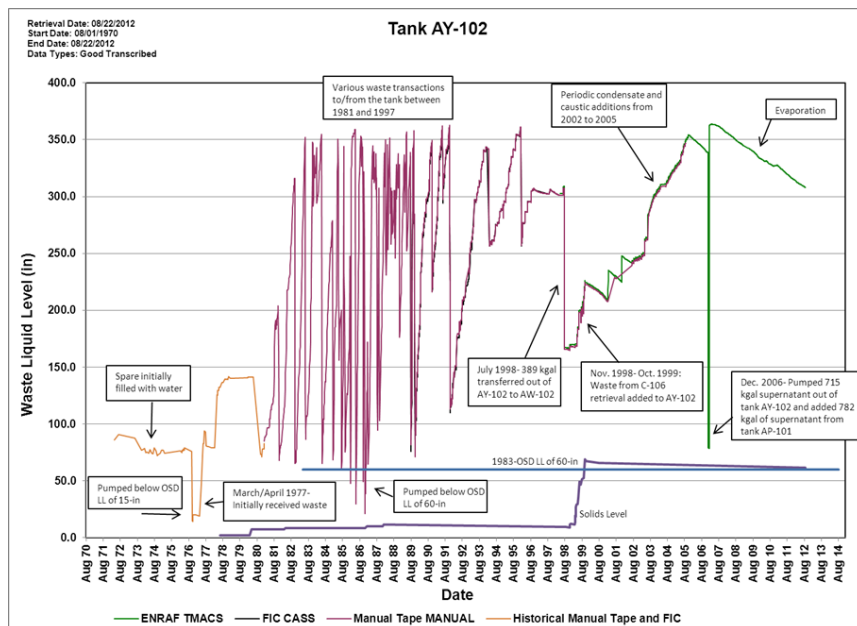
- Eight benchmarks in use – two with data since 1984 and six new benchmarks first recorded in 2006
- Dome deflections up to 0.5-inches (~ 0.04-feet) are within load limits¹
- Survey data show a maximum dome deflection of < 0.02-feet since record keeping began
- **No evidence of dome deflection or tank settlement.**

¹RPP-25782, DST Dome Survey Program, and RPP-RPT-25608, Hanford Double-Shell Tank Thermal and Seismic Project- Increased Concentrated Load Analysis



Fill Cycle Fatigue

washington river
protection solutions



- Cycle Fatigue evaluated in 1968 after structural modeling identified a region of the primary tank dome predicted to exceed minimum tensile stress.
- **Using ASME Section III Division I cycle fatigue guidance, safe cycles estimated to be 17,600**
- Backcheck using 2008 structural model results and 2010 version of code indicates ~ 25,000 safe cycles¹

¹ ASME Code, Section III, Division 1, "Rules for Construction of Nuclear Facility Components," Appendices, Figure I.9-1, "Design Fatigue Curves for Carbon, Low Alloy, and High Tensile Steels for Metal Temperatures not Exceeding 700°F," 2010 Edition, 2011a Addenda., and RPP-RPT-28968, Rev. 1, Hanford Double-shell Tank Thermal and Seismic Project – Summary of Combined Thermal and Operating Loads with Seismic Analysis

Tank Construction (Highlights)

- Tank Construction Difficulties
 - Secondary Liner Warpage
 - Insulating Refractory Cracking
 - Primary Tank Bottom Weld Rejection
 - Primary Tank Bottom Placement Refractory Concrete Depth Implications
 - Insulating Refractory Damage during Stress Relief and Hydrostatic Test of Primary Tank
 - Gaps beneath Primary Tank and Insulating Refractory



**Welding of Tank AY-102 Secondary Tank Bottom
(8051-1-Photo)**

➤ Secondary Liner Warpage

- Use of thin ¼-inch plates complicated by work in extreme cold (-20°F to -10°F) caused liner warpage . As plates were preheated and welded, convex bulges and wrinkles appeared.
- Flame heating and water fast quench partially eliminated wrinkles. But when plates were heated by the sun new wrinkles appeared. These did not disappear as temperatures chilled.
- February, 1969 survey found 22 liner locations exceeding allowable 2-inch convexity. Root-to-crown slopes up to 1-inch per foot were present, exceeding allowable 3/8-inch per foot.
- These were eventually accepted for placement of the insulating refractory.

► Primary Tank Bottom Weld Rejection

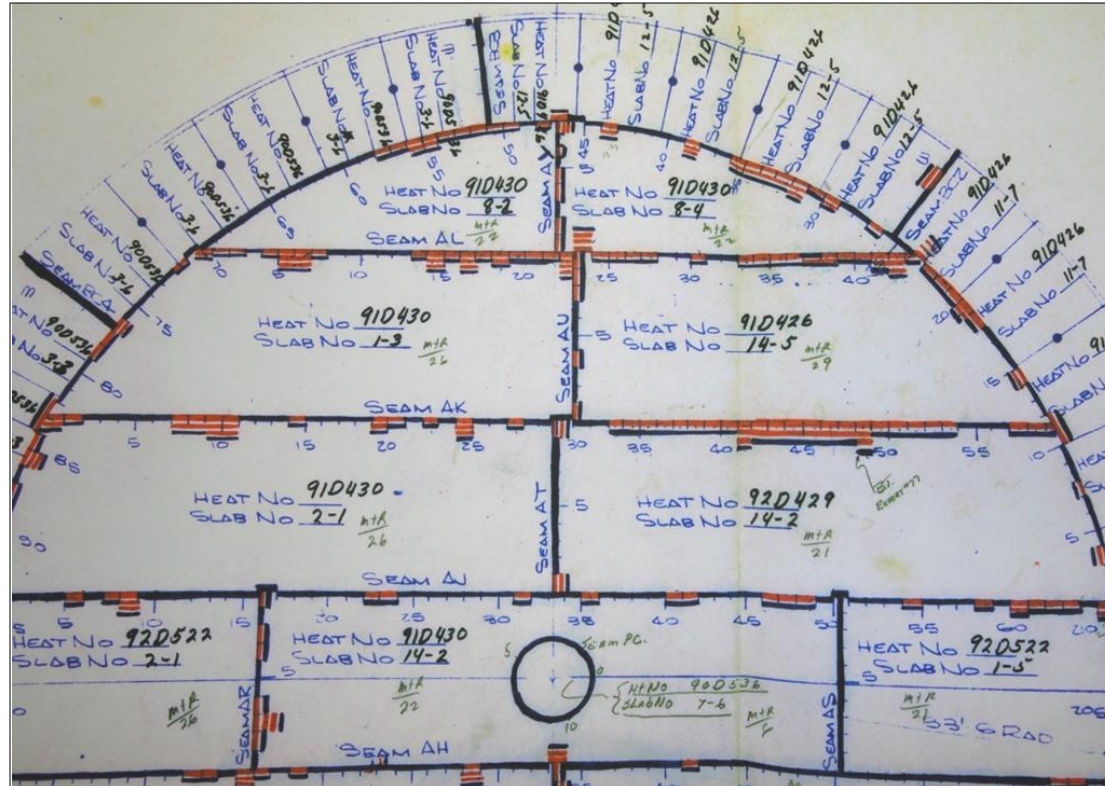
- Weld quality was a continuing concern. The floor plate weld rejection rate was ~ 36%.¹ Many welds were repaired several times before passing radiography.
- The radiography inspector accepted welds that were later rejected by the quality inspector.²

¹ By comparison the weld rejection rate for concurrent waste tank construction at the Savannah River Site was 10% - 20% (*Savannah River Plate Waste Tank Discussions and ITT Stress Analysis Study*, Trip Report); the weld rejection rate on AY-101 was 10%.

² Of 343 rejected floor plate welds, the inspector found only 294.



Tank Construction (cont.)



Primary Tank Bottom Plate Weld Map for northern section of tank showing rejected welds in red, and accepted welds in blue. The weld map shows instances of welds being repaired several times before passing inspection.

Tank Construction (cont.)

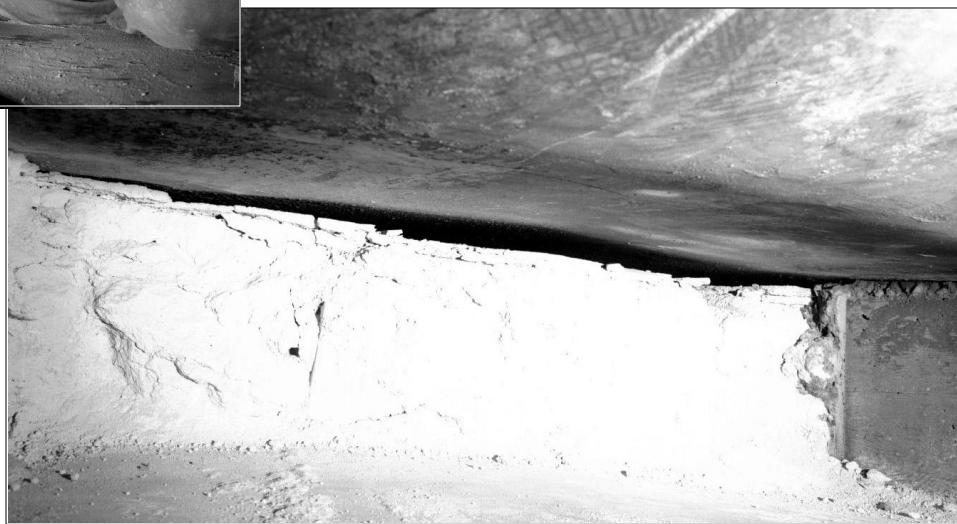
- ▶ Insulating refractory damage from stress-relief and hydrostatic test of primary tank
 - Full depth cracks ¼-inch wide extending several feet
 - Spongy top surface; affected depth increased as outer lip approached
 - Air passages blocked with spalled refractory
 - No evidence of tank settlement
 - Thought to result from skin friction as primary tank expanded and contracted across surface of refractory concrete pad during stress-relief, and “oil-canning” of the tank on the outside perimeter of the pad



Tank Construction (cont.)



Preparing Insulating Refractory for modification with use of reinforced concrete



Tank AY-101 Primary Tank Gap over Insulating Refractory (52788-8-Photo). Gaps in Tank AY-102 were reported to be larger.

Probable Leak Cause

- *Possible corrosion at high waste temperatures compounded by mechanical impacts to a tank whose waste containment margins had been reduced by construction difficulties.*

Tank AY-102 Leak Assessment Completion Activities

Recommendation: Leak Integrity Status of Tank AY-102 be changed from “Sound” to “Assumed Leaker – Primary Tank”